

Senior Design Project Description

Company Name	Duke McGuire Nuclear Station	Date Submitted	June 22, 2017
Project Title	Single Cell Battery Tester for Utilities (DUKE_BATT)	Planned Starting Semester	Fall 2017

Personnel

Typical teams will have 4-6 students, with engineering disciplines assigned based on the anticipated Scope of the Project. 250 hours are expected per person.

Complete the following table if this information is known, otherwise the Senior Design Committee will develop based on the project scope:

Discipline	Number	Discipline	Number
Mechanical	2	Electrical	3
Computer		Systems	
Other ()			

Project Overview:

There is no longer a single cell tester available to the utility industry. Several utilities with nuclear units have expressed continued interest in having this test equipment.

NRC regulations for nuclear safety related batteries are extremely rigorous. A single bad cell requires a station to have the cell replaced or jumpered out within hours or they must shutdown. To meet these requirements a station always wants to have several tested spares.

An automated single cell tester would allow maintenance to test a spare cell automatically and record results with minimal labor cost. This would help to make sure tested spare batteries are ready when needed.

Initial Project Requirements:

Design a test unit that can perform discharge tests on individual cells. The device needs to be able to maintain a constant discharge current as cell voltage drops.

The control unit SHALL have the following parameters programmable:

- Test Duration 1 min to 84 hours
- Duration to apply a load in minute intervals



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- Load profile(s)
- Test warning voltage:
- Minimum cell voltage for test shut off.
- Designed for testing lead acid batteries.
- Shunt rating

The control unit SHALL:

- Control the load cart based on inputs from the load profile
- Monitor analog voltage and current data at:
 - Start of test
 - at least every 10 seconds
 - End of test
- Be capable of performing the following tests per IEEE-450-2010 (load not compensated for cell temperature)
 - Performance Test
 - Service Test
 - Modified Performance Test
- Use a calibrated shunt for monitoring current
- Use a platform that is widely available and designed to be supported for many years in case replacement of controller is needed.

The load cart SHALL:

- Be capable of carrying at least 1000A of load. This may be accomplished by a single unit or connecting modular units in parallel
- Able to run for greater than 84 hours at 50A
- Have a means to disconnect from the battery in case of tester failure. Change load based on signal from tester unit.
- Use a shunt(s) for monitoring current.

The test data file SHALL

- Record Test Date and time of test
- Record Model and serial number of cell tested
- Record Test type
- Record Test parameters
- Record all data from test (from SHALL requirements and any chosen optional designs)
- Use a commonly used/supported file format
- SHALL have a template design to generate a test report file

The test report file SHALL:

- Show Test Date and time of test
- Show Model and serial number of cell tested
- Show Test type



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- Show Test parameters
- Show graphic of cell discharge profile of voltage over time and discharge current over time
- Show graphic of any Optional parameters over the discharge period.

Optional design considerations:

- Testing other battery chemistries and their voltage profile. (Nicaid and Li-Ion)
- Test multiple cells in series or block cells designs up to 6V.
- Tester capable of temperature compensated load testing (see IEEE-450-2010)
- Tester capable of recording battery temperature during discharge.
- Record real time ohmic data as battery discharges (purely for academic modeling)
- Capable of high speed data capture of first minute voltage profile.
- Test set has built in charger which starts automatically after discharge test, equalizes battery for a required time then returns to float. (This option may add significant scope to design and should only be considered AFTER scope and budget of SHALL requirements are met)

References:

IEEE-450-2010 IEEE Recommended Practice for Maintenance, Testing, and Replacement of Vented Lead-Acid Batteries for Stationary Applications

IEEE-485-2010 Recommended Practice for Sizing Lead-Acid Batteries for Stationary Applications

EPRI Stationary Battery Guide: Design, Application, and Maintenance Revision 2 of TR-100248

Expected Deliverables/Results:

- Single cell battery test prototype
- Bill of Materials of prototype
- All design documents/software
- User manual for maintenance personnel to perform tests
- Calibration manual, if unit calibration is required.

Disposition of Deliverables at the End of the Project:

Brian Casey to take possession after Expo.

List here any specific skills, requirements, knowledge needed or suggested (If none please state none):

Recommended design team background:

- Programming Windows based applications
- Programmable logic devices
- Power electronics
- Power systems



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- Equipment fabrication